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Pollution PREVENTION & CONTROL

Industrial Initiatives in Northern Alberta

Alberta
ENVIRONMENT

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Introduction

The Northern Rivers Ecosystem Initiative (NREI) was established to address the recommendations of the five-year Northern River Basins Study (NRBS) that comprehensively evaluated the effects of northern development on northern river ecosystems.

The recommendations and the governments' response identified pollution prevention as a primary environmental objective.

NRBS Recommendation 1.1 states:

> *Regulatory agencies for the northern rivers declare and implement, through law, policy, and practice, pollution prevention, including, but not limited to zero discharge, as a primary environmental objective and as an important component of sustainable development.*

The governments' response to Recommendation 1.1 states:

> *The governments of Canada, Alberta, and the Northwest Territories declare pollution prevention as a primary environmental objective and as an essential component of sustainable development.*

Although all environmental protection actions provide benefits, often the greatest opportunities for reducing environmental or health risks and associated costs are at the top of the hierarchy (see Table 1) with pollution prevention activities giving the greatest benefits.

The Canadian Council for Ministers of the Environment (CCME) defines pollution prevention as:

> *The use of processes, practices, materials, products or energy that avoid or minimize the creation of pollutants and wastes, and reduce the overall risk to human health or the environment.*
>
> *Pollution prevention promotes continuous improvement through operational and behavioural changes. Pollution prevention is a shared responsibility among governments and individuals, industrial, commercial, institutional, and community sectors.*

Partnerships and regulatory actions between governments and the private sector result in a broad and diverse spectrum of pollution prevention programs. Industry and businesses participating in these programs are finding both environmental and economic benefits by adopting pollution prevention processes and practices.

Integration of environmental actions into daily life is becoming more common as pollution prevention increases and effective partnerships are created.

Industries and municipalities in northern Alberta have already implemented pollution prevention initiatives within the northern river basins. This report summarizes some of the key steps that have been taken to reduce pollution from pulp mills and oil sands operations.

Progress has been made in incorporating pollution prevention into many of the decisions and activities of government, companies, communities and individuals. Work is continuing toward the goal of achieving a clean environment and healthy economy.

Table 1: Hierarchy of Environmental Practices from a Pollution Prevention Perspective

Activity	Example
Product or Service Changes	▮ Remove need for product/service
Product or Service Improvements	▮ Redesign or reformulate product /service ▮ Increase product life
Process or Technology Improvements	▮ Remove need for process ▮ Avoid/minimize generation of pollutants/waste by process ▮ Reduce raw material use ▮ Reduce water use ▮ Reduce energy use
Input or Raw Material Changes	▮ Substitute benign materials for polluting materials ▮ Minimize use of pollutant inputs
Operating Improvements	▮ Optimize operating efficiency, scheduling ▮ Improve maintenance procedures ▮ Inventory control ▮ Improve housekeeping practices ▮ Avoid/minimize losses/leaks/spills
Reuse or Recycling *(possibly preceded by control or containment*)*	▮ Reuse materials on-site ▮ Close process loops ▮ Recycle materials on-site ▮ Off-site reuse of waste/by-product materials ▮ Waste exchange ▮ Off-site recycling, reprocessing, material recovery, reclamation
Waste-to-Energy	▮ Burn wastes/by-products for energy value
Treatment or Destruction *(possibly preceded by control or containment*)*	▮ Biological treatment, possibly off-site ▮ Physical treatment ▮ Chemical treatment, e.g., neutralization, stabilization
Disposal *(possibly preceded by control or containment*)*	▮ Secure disposal, storage, encapsulation ▮ Landfill
Reclamation on Mitigation	▮ Site/soil remediation ▮ Ecosystem restoration ▮ Impact mitigation, increased health care requirements

CLOSER TO THE ROOT CAUSE OF POLLUTION

POLICY AND LAW — *pollution prevention as defined in Canadian policy and law*

TRADITIONAL — *traditional pollution control and waste management*

** eg. precipitation, scrubbing, baghouses, cycloning, screening, settling, filtration, dewatering, berming, shrouding, sumps, on-site spill cleanup, etc.*

Pollution Prevention Initiatives

Pulp Mills

Technology or Treatment Upgrades

Two main types of changes achieve pollution prevention/control:

1. Technology changes in a plant process that prevent the formation of pollutants. Examples of this include oxygen delignification and elemental chlorine free bleaching at pulp mills.

2. Treatment changes which reduce the pollutants before the end-of-pipe discharges. Examples of this include modifications to a wastewater treatment system, longer treatment times in a biological treatment system, or optimization of nutrient addition.

At the Alberta pulp mills, many technology and treatment upgrades have occurred since 1990 which have substantially reduced the contaminants in wastewater discharges. Table 2 summarizes some of the major changes and their effects on the wastewater quality.

Table 2: Changes in Process or Treatment Technologies and Their Effect on Wastewater Quality at Pulp Mills

Pulp Mill Name	Technology or Treatment Change	Effect on Wastewater Quality
Weyerhaeuser Company Limited (Grande Prairie)	100% Chlorine Dioxide Substitution (Elemental Chlorine Free or ECF bleaching) - 1992	Reduced Adsorbable Organic Halides (AOX) and dioxins and furans
	Installation of condensate stripper - 1993	Reduced BOD and odour
	Addition of peroxide to bleach plant wastewater - 1997	Reduced colour
Weldwood of Canada Ltd. (Hinton)	Increased chlorine dioxide substitution to 45% - 1990	Reduced AOX, BOD, colour, dioxins and furans
	Oxygen delignification - 1993	Reduced AOX, BOD, colour, dioxins and furans
	Conversion to ECF bleaching - 1993	Reduced AOX and dioxins and furans
Daishowa-Marubeni International Ltd. (Peace River)	Conversion to ECF bleaching - 1998	Reduced AOX, BOD, colour, dioxins and furans
Alberta Pacific Forest Industries Inc. (Boyle)	Change in cooling water chemicals	Reduced phosphorus in cooling water

ECF: *Elemental Chlorine Free bleaching where elemental chlorine (Cl_2) is not used in the bleaching sequence. Chlorine dioxide is used as a bleaching agent instead of elemental chlorine, substantially reducing the formation of chlorinated organics, and virtually eliminating the production of dioxins and furans.*

TSS: *Total Suspended Solids - TSS measures the amount of solid particulates*

BOD_5: *Biochemical Oxygen Demand - BOD is a measure of the organic matter in the effluent, which affects the amount of oxygen that will be used up in the river*

AOX: *Adsorbable Organic Halides - AOX represents the amount of chlorinated organics in the wastewater resulting from chlorine or chlorine dioxide bleaching of Kraft pulp*

EPEA : *Environmental Protection and Enhancement Act*

LIMITS

Alberta Environment establishes limits on wastewater discharges to minimize the impact of effluents discharged to river systems.

Figure 1: Reductions in Color Discharge Limits for Weyerhaeuser Canada Pulp Mill

Figure 1 shows the colour discharge approval limits for the Weyerhaeuser Grande Prairie pulp mill. Colour continues to be an aesthetic issue with the small size of the Wapiti River and consequently the mill has agreed to incorporate Oxygen Delignification (or equivalent) technology, which will, among other environmental benefits, reduce the colour discharges. The step down in limits allows the company to plan for the more stringent requirements, which may require large capital investment and significant changes to mill operation.

Colour limits for Weyerhaeuser have become increasingly stringent

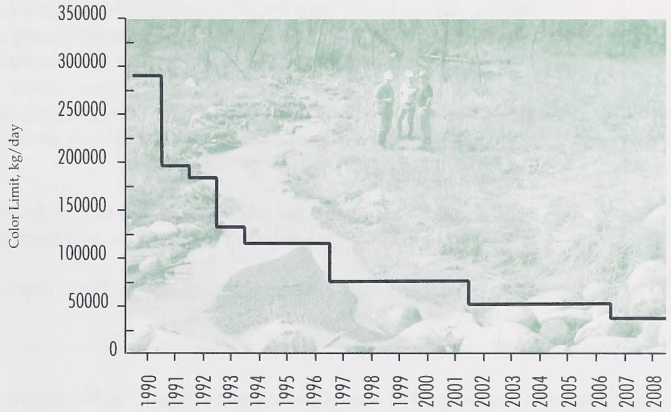
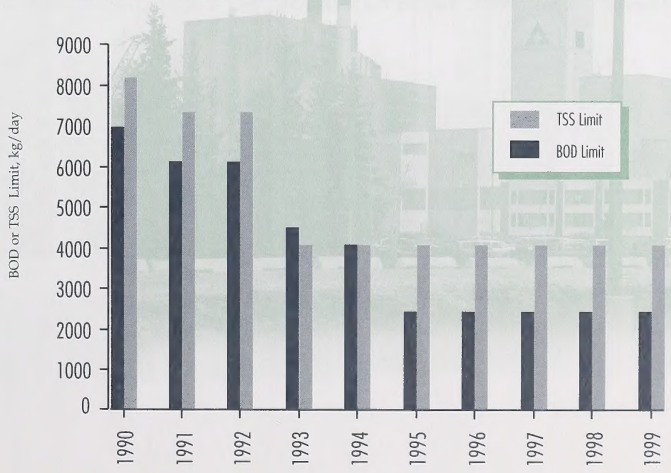


Figure 2: Reductions in Effluent BOD and TSS Discharge Limits for Weyerhaeuser Canada Pulp Mill

Figure 2 shows the Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS) approval limits for Weyerhaeuser's mill. Both these limits have been reduced to protect the Wapiti River. BOD is a measure of the organic matter in wastewater which uses oxygen during the natural decomposition process in a receiving environment.

Biochemical Oxygen Demand (BOD) and Total Suspended Solids limits have become increasingly stringent for the Weyerhaeuser pulp mill



PULP MILL RESIDUE UTILIZATION

Another example of pollution minimization strategies is the use of pulp mill by-products for a beneficial use. The main disposal methods for these materials were incineration and landfilling, which generated air emissions or used up landfill space. Alberta Thermo-Mechanical-Pulp (TMP) mills have found a beneficial use for their solid sludge material produced from their wastewater treatment systems. TMP sludge consists primarily of water, wood fibre, biomass, and residual process and wastewater treatment chemicals (mainly nutrients such as nitrogen and phosphorus). With proper environmental controls, these sludges can be managed as by-products rather than industrial wastes.

An Alberta research program initiated in 1991 with the three TMP mills, Alberta Environment, Alberta Agriculture, and the Alberta Research Council, demonstrated that the material is a good soil amendment. The benefits of sludge application on land are:

1. The sludge improves the nutrient status and physical properties of soil resulting in enhanced plant growth. Studies conducted by the Alberta Research Council and Alberta Agriculture to date have demonstrated significant increases in crop yields resulting from the nutrient content in the sludge and the improved water holding capacity and porosity of the soil from the organic content of the sludge.

2. When applied at recommended rates and managed properly, sludge improves soil quality. The results of Alberta Research Council work were interpreted in the context of the Alberta soil quality criteria guidelines.

3. Land application reduces the volume of sludge that is placed in landfills thereby extending landfill life and reducing the need for new landfill construction.

4. Land application reduces the volume of sludge that is disposed by incineration, thereby reducing air emissions.

Guidelines were developed to ensure protection of human health and the environment, while allowing for the beneficial use of the sludge on agricultural land. These standards and guidelines represent the compilation of extensive research work that has been performed regarding the environmental effects and fate of the land application of TMP sludge in an agricultural setting. The guidelines incorporate pollution prevention strategies to limit sludge applications on any site to amounts that are sustainable and thus avoid contamination of the environment.

The use of the pulp mill sludge has allowed a waste material to be converted to a beneficial product. On the Hierarchy of Environmental Practices shown in Table 1, reuse of the material has moved this industry further up the hierarchy, and closer to addressing the root cause of pollution.

EMISSIONS

Figures 3 and 4 show pulp mill performance from 1990 to 1999. The four wastewater emission parameters shown on the graphs are Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), Colour, and Adsorbable Organic Halides (AOX). TSS measures the amount of solid particulates discharged in the pulp mill effluent. BOD is a measure of the organic matter in the effluent, which affects the amount of oxygen that will be used up in the river. Microorganisms naturally break down organic compounds in the wastewater and consume oxygen in the process. Lower organic content (as shown by lower BOD values) means less oxygen will be used from the receiving stream and the aquatic ecosystem will be healthier. Colour measures the visible colour of the effluent. AOX represents the amount of chlorinated organics in the wastewater resulting from chlorine or chlorine dioxide bleaching of Kraft pulp.

Figure 3: Summary of Alberta Pulp Mill Performance

Figures 3 illustrates how overall loadings of contaminants in wastewater from pulp mills have decreased over time. The mills, through both provincial requirements and their own pollution prevention/control initiatives, have implemented technologies that reduce emissions to the environment.

Average mass (kg/day) discharges from pulp mills have decreased substantially from 1990 to 1999

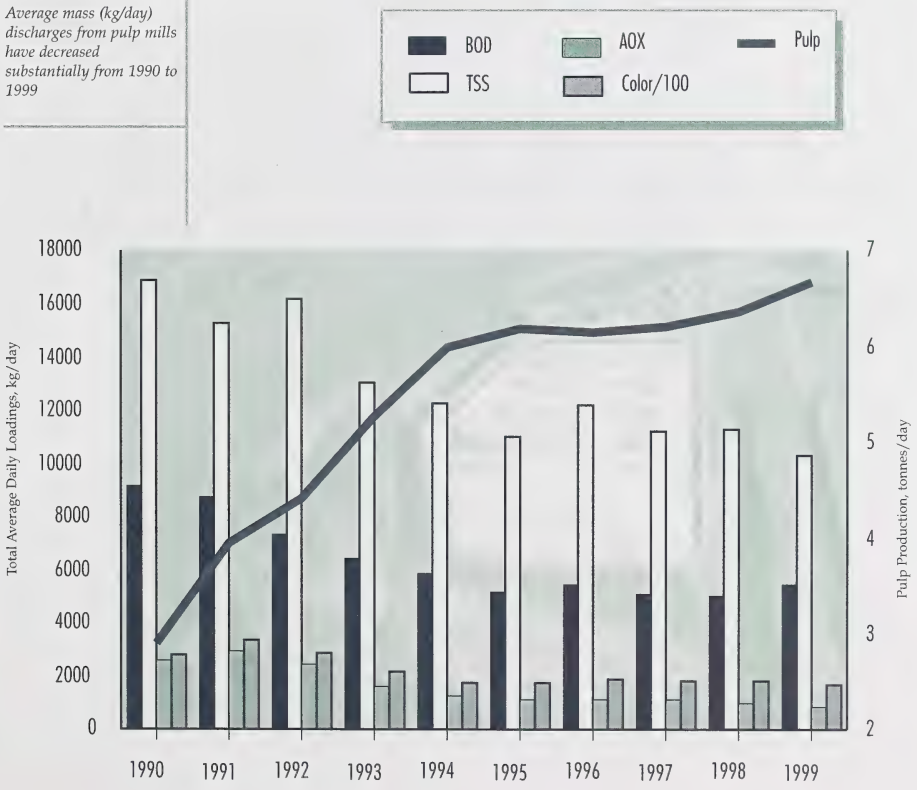
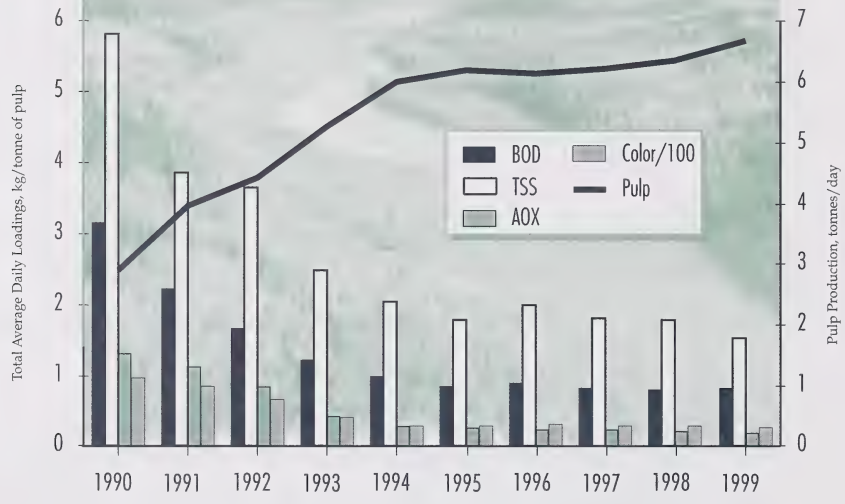


Figure 4: Summary of Alberta Pulp Mill Performance

Figure 4 demonstrates the continuous improvement made in producing pulp efficiently while improving the wastewater quality. Alberta pulp mills were also able to reduce the total amount of pollution going to Alberta's rivers despite more than doubling the total amount of pulp produced from 1990 to 1999.

Decreasing contaminants show improved environmental efficiency at pulp mills



Dioxins and furans are two bioaccumulative persistent toxics that have previously been associated with pulp mill effluent from bleached Kraft mills. The formation of these compounds can be substantially prevented by the use of in-plant process technologies such as oxygen delignification, extended delignification, and 100% chlorine dioxide substitution in the bleaching process (Elemental Chlorine Free or ECF bleaching). Three of the four Alberta Kraft mills have oxygen delignification and ECF bleaching in place. The final mill, Weyerhaeuser, will install oxygen delignification or an equivalent process by 2002. The four bleached Kraft mills in Alberta did not have detectable levels of 2,3,7,8 TCDD (the most toxic form of dioxin) in 1997, 1998, or 1999. The levels of furans in mill effluent have remained below the limit of 50 parts per quadrillion as set out by the federal government.

Nutrients, such as nitrogen and phosphorus are a concern in rivers because they have the potential to cause eutrophication, or excessive growth of algae. Nutrients are mainly an aesthetic concern, but at higher concentrations, they can also affect the ecosystem. Nitrogen and phosphorus can enrich a nutrient-poor system and provide additional food to support aquatic life. High nutrient loads can also contribute to eutrophication by causing excessive algae growth which can decay and reduce oxygen.

Figure 5: Average Nitrogen Discharges per Pulp Mill

Most pulp mills add nutrients to their wastewater treatment systems to improve the ability to biodegrade organic material and reduce the amount of BOD which is discharged to the rivers. Since 1995, total nitrogen (a sum of ammonia-, organic-, nitrate-, and nitrite-nitrogen forms) has remained approximately the same.

Nitrogen discharges from pulp mills have remained relatively constant over the last five years, with a slight decrease in 1999

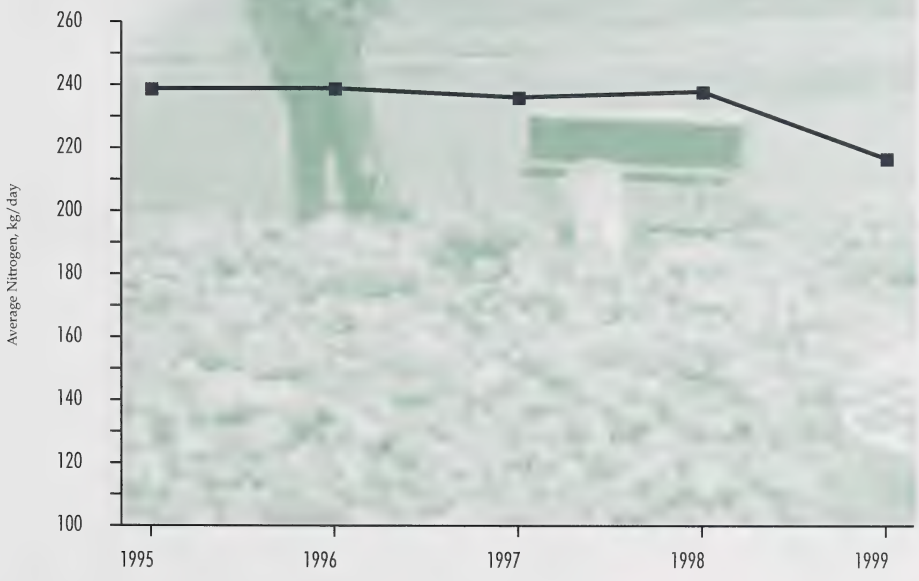
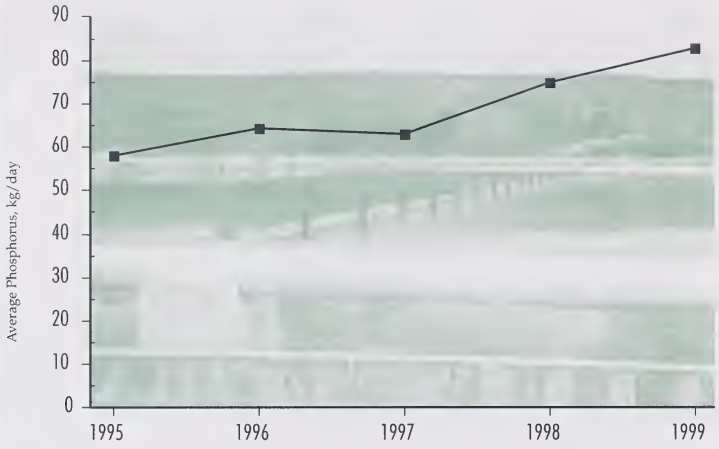


Figure 6: Average Phosphorus Discharges per Pulp Mill

Phosphorus loadings have increased over the same period. Most mills are required to submit nutrient minimization proposals detailing plans to reduce nutrients while maintaining good BOD and toxicity removal. Nutrients and BOD removal are often "trade-offs" in pollution prevention and control; in order to minimize BOD, more nutrients typically have to be added to a treatment system.

Phosphorus discharges from pulp mills have increased 43% since 1995



Oil Sands
Technology or Treatment Upgrades

EMISSIONS

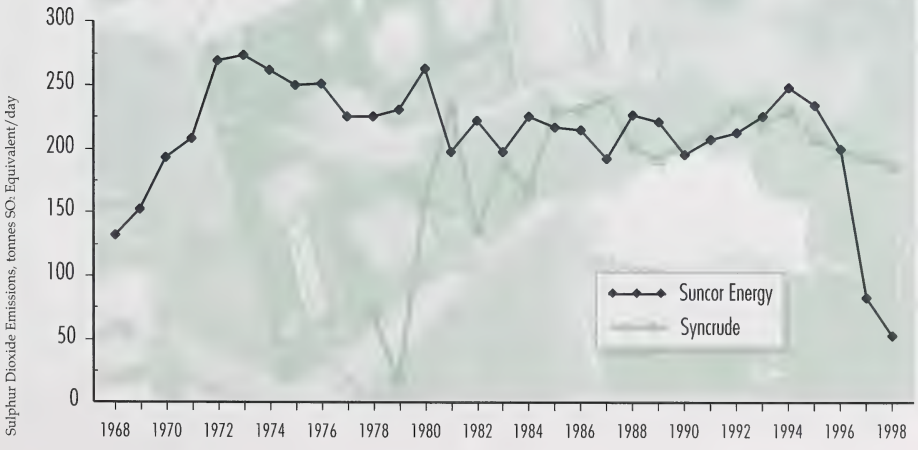
Syncrude's oil sands operation does not discharge industrial process wastewater. Suncor discharges an industrial wastewater stream from its upgrader to the Athabasca River. Both operations use tailings ponds as impoundments for the slurry of tailings and wastewater produced from extracting the oil from the tar sands. The tailings pond wastewater is also recycled back to the plants to minimize the fresh water withdrawals from the Athabasca River.

The air emissions from the oil sands are a concern because of deposition of compounds such as sulphur dioxide or oxides of nitrogen, which can cause acidification of soil or water. Volatile Organic Compounds (VOC) from solvents can cause odours. In 1997, Suncor installed a Flue Gas Desulphurization unit and made improvements to their upgrader sulphur plant to reduce sulphur dioxide emissions. These pollution control changes reduced sulphur dioxide emissions by over 60% from their previous annual average emission. Figure 7 shows the sulphur dioxide emissions from both oil sands operations.

Suncor and Syncrude have also reduced the release of VOCs through improved technology in vapour recovery from storage tanks, naphthene (solvent) recovery from wastewater, and improvements in the types of solvents used. Leak detection and repair programs at oil sands mines have also reduced the release of VOCs from pipes.

Figure 7: Sulphur Dioxide Emissions

Historical sulphur dioxide emissions from the two oil sands operations near Fort McMurray. Recent improvements at Suncor Energy have dramatically reduced emissions



Flaring from both oil sands operations has been reduced, as shown in Figures 8 and 9. Flaring is typically done during start-up, shutdown, or process upset conditions and can release sulphur dioxide as well as other air contaminants without control technologies minimizing the releases.

Figure 8: Suncor SO_2 Flaring Emissions

Sulphur dioxide flaring emissions from Suncor Energy oilsands showing a general decline from the early 1980's to current

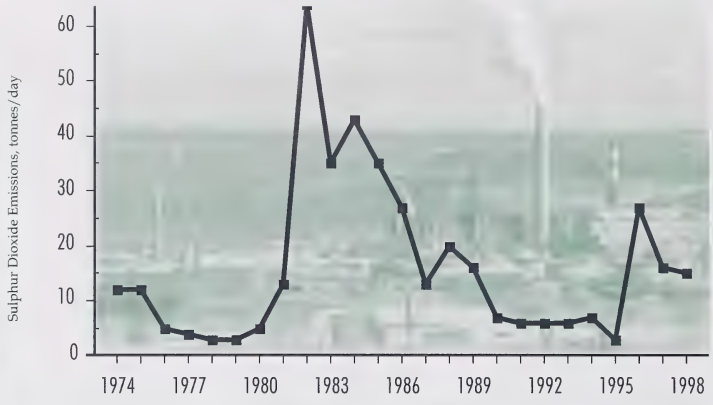
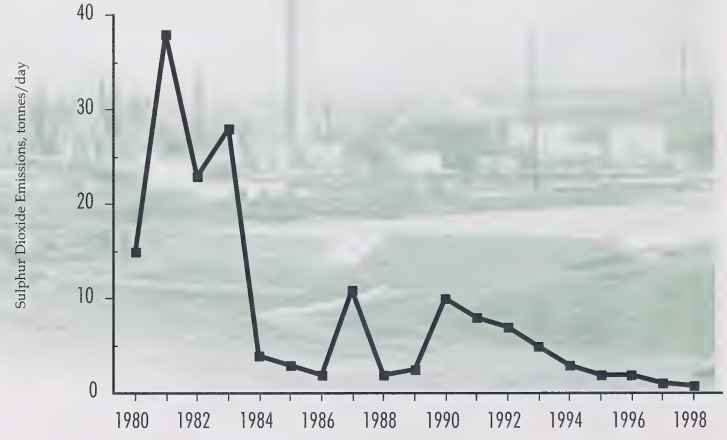


Figure 9: Syncrude Canada SO_2 Flaring Emissions

Sulphur dioxide flaring emissions from Syncrude Canada oilsands showing reduction from the early 1980s to current



Reductions in flaring also result in a decrease in other constituents such as oxides of nitrogen, Volatile Organic Compounds, and Total Reduced Sulphur compounds released to the atmosphere.

Improvements in the operation and reliability of technology has also reduced the incidents of flaring at the Suncor and Syncrude plants.

Other Initiatives

A number of pollution prevention or control modifications have been practised across the province by various industrial sectors to reduce the amount of contaminants entering the atmosphere. Examples of these pollution prevention and control practices include:

- The use of low oxides of nitrogen (NOx) burners to avoid the formation of oxides of nitrogen.
- Operation of wood dryers at lower temperatures to reduce VOC emissions from oriented strand board plants.
- Collection and incineration of process vent gases in furnace and boiler operations. This not only reduces the VOC emissions, but also generates heat for other processes.
- Reduction of wood residues by using thin bandsaws to minimize sawdust. This reduces the amount of sawdust typically disposed of through incineration.
- By-product synergy by using wood residues from industrial facilities for power generation.
- Reduced fugitive emissions from various industrial sectors by decreasing the number of flanges or connections. These connections can be replaced with welded joints, specially designed control valves, pumps, and compressors.

Alberta Environment
Pollution Prevention and Voluntary Initiatives

Alberta Environment wants to build on the pollution prevention and voluntary actions that have been successful in the Northern River Basins and elsewhere in the province. Such actions have the potential to deliver significant improvements beyond what can be achieved through a traditional command and control approach to pollution.

The department is investigating ways to encourage, recognize and reward voluntary initiatives from industry and municipalities. Industrial and municipal plant operators are in the best position to identify actions that will deliver cost savings as well as measurable outcomes that benefit the environment.

Alberta Environment will stress pollution prevention as a preferred approach in these innovative actions. The department is developing a formal approach to pollution prevention which initially will stress voluntary action but may eventually include integration with mandatory, regulatory requirements.

Environment Canada
Pollution Prevention Initiatives

The government of Canada is committed to pollution prevention and views it as a primary environmental objective and an essential component of sustainable development. Environment Canada implements this commitment through its policy entitled "Pollution Prevention - A Federal Strategy for Action (1995)."

The Canadian Environmental Protection Act (CEPA) enshrines pollution prevention as the preferred approach to environmental protection in Canada. Part 4 of the renewed CEPA provides the Minister with authority to require the preparation and implementation of pollution prevention plans for CEPA toxics.

Environment Canada is looking at ways to promote pollution prevention to municipalities within the river basins. A key strategy is to provide education to those within the basin on how they can individually and collectively contribute to pollution prevention. Focusing on municipal bylaw changes as a means to reducing toxic discharges to community sewer systems within a basin is one such area of activity proposed.